Research Note 2015-02

Assessing the Use of Game-Based Exercises in the Staff Attack-the-Network Course

Martin L. Bink
U.S. Army Research Institute

John T. Miller, II
Consortium of Universities of Washington

June 2015

United States Army Research Institute
for the Behavioral and Social Sciences

U.S. Army Research Institute
for the Behavioral and Social Sciences

Department of the Army
Deputy Chief of Staff, G1

Authorized and approved:

MICHELLE SAMS, Ph.D.
Director

NOTICES

DISTRIBUTION: This Research Note has been submitted to the Defense Information Technical Center (DTIC). Address correspondence concerning ARI reports to: U.S. Army Research Institute for the Behavioral and Social Sciences, Attn: DAPE-ARI-ZXM, 6000 6th Street Building 1464 / Mail Stop: 5610), Fort Belvoir, VA 22060-5610.

FINAL DISPOSITION: Destroy this Research Note when it is no longer needed. Do not return it to the U.S. Army Research Institute for the Behavioral and Social Sciences.

NOTE: The findings in this Research Note are not to be construed as an official Department of the Army position, unless so designated by other authorized documents.

REPORT DOCUMENTATION PAGE

1. REPORT DATE (dd-mm-yy)	2. REPORT TYPE	3. DATES COVERED (from. . . to)
June 2015	Final	August 2013 - December 2014

4. TITLE AND SUBTITLE	5a. CONTRACT OR GRANT NUMBER
Assessing the Use of Game-Based Exercises in the Staff Attack-the-Network Course	5b. PROGRAM ELEMENT NUMBER 622785

6. AUTHOR(S)	5c. PROJECT NUMBER
Martin L. Bink (U.S. Army Research Institute); John T. Miller, II (Consortium of Universities of Washington Fellow, Capella University)	A790
	5d. TASK NUMBER 225
	5e. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)	8. PERFORMING ORGANIZATION REPORT NUMBER
U.S. Army Research Institute for the Behavioral and Social Sciences 6000 6th Street (Building 1464/Mail Stop: 5610) Fort Belvoir, VA 22060-5586	

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. MONITOR ACRONYM
U.S. Army Research Institute for the Behavioral and Social Sciences 6000 6th Street (Building 1464/Mail Stop: 5610) Fort Belvoir, VA 22060-5586	ARI
	11. MONITOR REPORT NUMBER Research Note 2015-02

12. DISTRIBUTION/AVAILABILITY STATEMENT: Distribution Statement A.
Approved for public release; distribution is unlimited.

13. SUPPLEMENTARY NOTES

Subject Matter POC: Martin L. Bink

14. ABSTRACT *(Maximum 200 words)*: The U.S. Army increasingly relies on serious games as a training tool for tactical tasks. The use of game-based exercises is nonetheless a novel approach for training human-intelligence tasks. In order to determine the extent to which a virtual game-based environment provided an effective means to apply human-intelligence skill, two forms of scenario-based practical exercises were compared in the Attack the Network course. Course performance and perceptions of training were compared across students who completed traditional paper-based practical exercises and students who completed practical exercises based in the Army's Enhanced Dynamic Geo-Social Environment game-based training environment. The game-based practical exercises did no better in increasing end-of-course test scores than did traditional paper-based practical exercises. In addition, the paper-based practical exercises were perceived as more beneficial to learning and course outcomes as compared to the game-based practical exercises. These results add to the growing literature that fails to find a relative advantage of game-based training.

15. SUBJECT TERMS

Training- Gamed- based, Intelligence (Human), Skills

SECURITY CLASSIFICATION OF			19. LIMITATION OF ABSTRACT	20. NUMBER OF PAGES	21. RESPONSIBLE PERSON
16. REPORT	17. ABSTRACT	18. THIS PAGE			
Unclassified	Unclassified	Unclassified	Unlimited Unclassified	30	Dorothy Young 703-545-2316

ARI Research Note 2015-02

Assessing the Use of Game-Based Exercises in the Staff Attack-the-Network Course

Martin L. Bink
U.S. Army Research Institute

John T. Miller, II
Consortium of Universities of Washington

Fort Benning Research Unit
Scott E. Graham, Chief

June 2015

ACKNOWLEDGEMENT

The authors would like to express their gratitude to the Soldiers from Fort Benning, Fort Buchanan, Fort Campbell, Fort Carson, Fort Dix, and Camp Ripley for their participation in the research and for their professionalism. Likewise, the authors wish to acknowledge Tatiana Rivera from Maneuver Center of Excellence Directorate of Doctrine and Training and Anthony Dodd, Bryan Beverly, and Marvin Herron from the Staff Attack the Network Mobile Training Team for support of the research.

ASSESSING THE USE OF GAME-BASED EXERCISES IN THE STAFF ATTACK-THE-NETWORK COURSE

EXECUTIVE SUMMARY

Research Requirement:

The U.S. Army increasingly relies on serious games as a training tool for tactical tasks. The use of game-based exercises is nonetheless a novel approach for training human-intelligence tasks. Human-intelligence tasks are the actions related to collecting information from people and other sources (i.e., social networks, print, and visual media) to identify elements, intentions, composition, strength, dispositions, tactics, equipment, personnel, and capabilities. In order to determine the extent to which a virtual game-based environment provided an effective means to apply human-intelligence skills, two forms of scenario-based practical exercises were compared in the Attack-the-Network (AtN) course.

Procedure:

AtN course performance and perceptions of training were compared across students who completed traditional paper-based practical exercises and students who completed practical exercises presented in the Army's Enhanced Dynamic Geo-Social Environment game-based training environment.

Findings:

The game-based practical exercises did no better in increasing end-of-course test scores than did traditional paper-based practical exercises. In addition, the paper-based practical exercises were perceived as more beneficial to learning and course outcomes compared to the game-based practical exercises. These results add to the growing literature that *fails* to find a relative advantage of game-based training.

Utilization and Dissemination of Findings:

The findings from the current research were briefed to the Maneuver Center of Excellence Directorate of Training and Doctrine and to the U.S. Army Research Laboratory – Human Research and Engineering Directorate Simulation and Training Technology Center. The findings were used to inform decision about including game-based training in AtN.

ASSESSING THE USE OF GAME-BASED EXERCISES IN THE STAFF ATTACK-THE-NETWORK COURSE

CONTENTS

Page

LIST OF FIGURES

ASSESSING THE USE OF GAME-BASED EXERCISES IN THE STAFF ATTACK-THE-NETWORK COURSE

Introduction

The U.S. Army soldier trains in a variety of learning environments (e.g., Live, Virtual, and Constructive). Previous and ongoing lessons learned from the Contemporary Operational Environment provides relevance to planning, rehearsing, and practicing decision-making on topics related to mission success. Over the course of several years, the U.S. Army increasingly relies on serious games as a training tool for direct-fire and indirect-fire tactical tasks. Although the use of game-based exercises is not new for schoolhouse courses or unit-based training on combat tactics, techniques, and procedures, the use of game-based exercises is nonetheless a novel approach for training human-intelligence tasks. Human-intelligence tasks are the actions related to collecting information from people and other sources (i.e., social networks, print, and visual media) to identify elements, intentions, composition, strength, dispositions, tactics, equipment, personnel, and capabilities (Department of the Army, 2011). Currently, these skills are trained in the U.S. Army's Staff Attack the Network (AtN) course.

The question remains, however, whether or not game-based training environments are effective for applying human-intelligence skills. In order to determine the extent to which game-based training provided an effective means to apply human-intelligence skill, two forms of scenario-based practical exercises were compared in the AtN course. Student performance on traditional paper-based practical exercises was compared to performance on practical exercises based in the Army's Enhanced Dynamic Geo-Social Environment (EDGE) game. This research was conducted in support of the U.S. Army Maneuver Center of Excellence Directorate of Training and Doctrine to determine possible enhancements to the AtN course. The present report describes results of this comparison and the implications for training human-intelligence skills and game-based training.

Games Used in Military Training

Games have long been used to train military decision making. The first widely-known military decision-making game was introduced in 1644, and simulations of unit size, terrain, visualization of movement and actions, and rate of individual or unit speed appeared in the early 1800s (Gray, 1995). Since that time, complex decision-making simulations have been used to analyze and train the components of organizational operations. Game-based training offers a low-cost alternative to full simulation or constructive training environments (e.g., Ratwani, Orvis, & Knerr, 2010). Game-based training also facilitates self-paced or individually-adaptive training (Blankenbeckler, Graves, & Wampler, 2013).

Even with the long history of training games, few evaluations of instructional effectiveness were conducted before the late 1980's (Hays, 2005). As commercial off-the-shelf video game technologies were applied to training games, more research on training and assessment of military decision-making games has emerged. It is fairly well documented that game-based training increases motivation to train during game play (Dickey, 2007; Ryan, Rigby & Przybylski, 2006; Vogel, Greenwood-Ericksen, Cannon-Bowers, & Bowers, 2006) and that

game-based training is perceived as challenging (Beal, 2007; Singer, Long, Stahl, & Kusumoto, 2008). Moreover, demonstrations of effective game-based training in military settings exist when games are used as primary instruction (Pleban & Salter, 2001; Ratwani, et al., 2010) or as supplemental instruction (Topolsky, et al., 2010).

However, it is not clear if the apparent benefits of game-based training translate to actual increases in learning or performance compared to traditional modes of training (Topolski et al., 2010). Most research on game-based training effectiveness simply analyzes the increase in performance from a baseline (i.e., absolute effectiveness) as opposed analyzing the increase in performance compared to another mode of training (i.e., relative effectiveness). For example, there are few results that show that game-based training provided larger increases in training performance or retention than direct instruction or paper-based exercises (Hays, 2005). There is also little evidence to suggest that game-based training transfers to actual task execution (Hays; Temby, Stephens, & Whitney, 2008).

The lack of research on relative effectiveness, coupled with the lack of evidence of transfer and with the ever-present confounding factors described in the research literature, makes it difficult to determine if game-based training would be effective for human-intelligence skills. In addition to increasing training motivation, game-based training has been shown to provide additional complexity to training (Singer, et al., 2008; Wolfe, 1997) and higher operational relevance (Lampton, Clark, & Knerr, 2003) compared to traditional modes of training (e.g., paper-based exercises). Because human-intelligence skills require decisions in complex and ambiguous situations, game-based training may be especially suited for use in AtN. Moreover, a consistent contributing factor to game-based training effectiveness is instructor/leader facilitation of the training (Beal, 2009; Pleban & Salter, 2001; Ratwani, et al., 2010), which is a salient characteristic of AtN training.

Attack the Network Course

AtN is a 1-3 day traditional classroom course of instruction that introduces the fundamentals of human intelligence collection to battle staff personnel and their supporting Company Intelligence Support Team (CoIST). The course focuses on mission planning for targeting social network activities. The targeting principles taught in the AtN course applies to intelligence collections of various social networks (i.e., criminal, friendly, and belligerent) with the end state of disrupting enemy network operations. Utilizing ten blocks of instructions, Soldiers are introduced to methodologies and lethal/non-lethal targeting methods to defeat, enable, or influence networks in the Area of Operations (AO). Traditionally, a series of practical exercises using paper-based scenarios provide an opportunity for Soldiers to apply, analyze, and synthesize network-engagement information received during the class lecture. As a comparison for the paper-based exercises, the EDGE game was introduced to the AtN course.

Enhanced Dynamic Geo-Social Environment

EDGE utilizes a commercial game engine as well as traditional simulation and game-industry standards to produce a training platform (Dwyer, Griffith & Maxwell, 2011). EDGE allows players to control an in-game avatar (see Figure 1), navigate terrain, and use vehicles,

equipment, and tools for a variety of social-cultural task and other actions (see Figure 2). During a capabilities demonstration in 2013, first responders and other emergency workers (e.g., Homeland Security and dispatchers) used EDGE to train in complex situations. The platform allowed first responders from across jurisdictions to navigate geo-specific terrain; utilize ultra-high resolution vehicles, equipment, and tools to execute on-site practices and procedures.

Figure 1. EDGE Player Avatar.

Figure 2. EDGE Operational Environment.

Method

The basic methodology consisted of collecting pre-test and post-test knowledge scores and questionnaire responses from Soldiers completing the AtN course using either traditional paper-based practical exercises (i.e., Control Group) or EDGE-based practical exercises (i.e., EDGE Group). The classroom instruction was the same for all participants and the only variation in the course was the conduct of the practical exercises. AtN is a mobile-training course

provided to units preparing to deploy. As such, there is wide variation in course locations and in the military occupation specialties of the students. Every effort was made to balance this variability across the experimental conditions (i.e., Control Group or EDGE Group).

Participants

Data from 193 participants was collected from eight AtN classes at seven Army installations. The installations were a combination of active component, reserve component, and National Guard in both the contiguous United States and outside the contiguous United States. Each class was assigned to one of two experimental conditions (i.e., Control or EDGE) in quasi-random order. Because the entire class participated in the same condition, the two experimental groups somewhat differed on the number and types of military occupation specialty (see Table). Four participants failed to complete both the pre-test and the post-test. The data for those participants were removed, and the effective sample sizes were 100 for the Control Group and 89 for the EDGE Group.

Table.
Participant Military Occupation Specialties.

	Control	EDGE
Military Intelligence	15	30
Infantry	14	15
Military Police	37	15
Civil Affairs	24	-
Engineer	-	8
Field Artillery	-	7
Other	13	15
Total	103	90

Materials

Pre-test and Post-test. The AtN course test consisted of 27 completion (i.e., "fill-in-the-blank") items for six problem-based themes: (1) Understanding the mission; (2) Understanding the Operational Environment; (3) Understanding Networks; (4) Organize for the Fight and Engage the Network; (5) Targeting; and (6) Assessment (e.g., was End State achieved?). The course test was used as the post-test, and an alternate form of the course test was developed by course managers to be used as the pre-test. Both tests addressed the six course themes and assessed the same type of information but differed in specific content. Answers for each test were provided on formatted worksheets. The tests were scored by AtN course instructors according to the approved course scoring rubric. There were a total of 100 points possible on each test.

Paper-Based Practical Exercise. The paper-based AtN Practical Exercise consisted of an introduction and a four-part scenario-based problem. The practical exercises were completed in small groups. Each part has a specific goal for the group to complete (e.g. determine any critical gaps in information) that corresponded to the just-completed block of instruction. The scenario for each part was provided in a hand-out, and each group was given a booklet with information about the AO (i.e., and intelligence brief). The groups were required to justify their decisions for each part during back briefs to the commander role-player in the classroom.

In Part I, Operational Environment Analysis, group members read the operational environment (OE) brief and Commander's intent and were directed to pay attention to the descriptions of the operational variables and civil considerations in the AO. The group goal was to identify five key facts about the OE. In Part II, Pattern Analysis, a 24-hour day scenario provided an opportunity to capture real-time intelligence. This intelligence was used to develop a pattern-analysis tool and products to report critical incidents (i.e. improvised explosive devise [IED] encounter). The goal of Pattern Analysis was to determine any critical gaps in information and to determine the kind of information one would request from an enabler (e.g. Counter IED).

In Part III, Network Analysis, group members collaborated to identify required actions to complete an activity model by monitoring network actors (e.g. bomb makers, planners, and videographers) and network locations (e.g. auto shops and shopping markets). Using a completed activity matrix, groups identified 11 character interactions and documented the time and location of the interactions. In Part IV, Targeting and Assessment, group members worked together to identify friendly, neutral, and threat networks in the AO and to develop a plan that integrated lethal and non-lethal actions to generate direct and indirect effects.

EDGE Practical Exercise. The EDGE-based Practical Exercise consisted of six virtual-world days of human-intelligence activities in a fictitious country. Students were divided into small groups depending on class size and remained with their assigned group through completion of the Practical Exercise. At the end of the final block of classroom instruction, the entire class was introduced to the EDGE game (e.g., using action menu and controls) and completed familiarization with the action menu. After the introduction, students began game-play by entering the virtual OE, were directed to reference materials, received an OE brief and operations order from a Commander avatar, and were directed to pay attention to the descriptions of the operational variables and civil considerations in the AO. The goal of the game was to interact with friendly, neutral, and hostile avatars in the OE, collect and disseminate information between group members, and collaborate on decisions to support, monitor, or neutralize networks. Specific task challenges and decision-making events were conducted during virtual Days 1 – 6. On virtual Day 7, each group received a virtual After Actions Review (AAR) on courses of actions and the first-order effects and second-order effects of their decisions.

AtN Post-Training Questionnaire. The AtN Post-Training Questionnaire captured participants' post-training perceptions of the AtN practical exercises. The questionnaire collected background information and contained items to assess the participants' knowledge and experience with other methods of decision-making, problem-solving, and mission analysis and tactical risk analysis (i.e., Troop Leading Procedures). The questionnaire also contained 16 items to capture perceptions of how the practical exercises influenced learning of specific AtN

skills and of overall understanding of AtN concepts. The perception items were rated on a 4-point Likert-type scale with anchors at "strongly agree" and "strongly disagree." The AtN Post-Training Questionnaire is provided in Appendix A.

Procedure

The pre-test was administered prior to classroom instruction to assess Soldiers' existing level of knowledge on conducting AtN-related activities. Soldiers were given 45 minutes to complete the pre-test. Classroom instruction for all students included ten blocks of instructions. Each block of instruction lasted approximately two-hours and introduced students to methodologies and lethal/non-lethal targeting methods to defeat, enable, or influence networks in an AO. Participants in the Control Group (i.e., paper-based practical exercises) were given a practical exercise at the end of each day of training and completed the practical exercises as previously described. Participants in the EDGE Group were given the practical exercise after the final block of training on the last training day and completed the practical exercise as previously described. This procedural confound will be addressed in the Discussion section.

After the completion of all practical exercises, students were given the post-test. Again, students were given 45 minutes to complete this test. Once the post-test was completed, the AtN Post-Training Questionnaire was administered. Students were given as much time as necessary to complete the questionnaire, and most students finished the questionnaire in about 20 minutes. Finally, participants were debriefed about the purposes of the research and the final administrative tasks for the course were completed.

Results

The relative effectiveness of game-based exercises in the AtN course was determined by comparing the differences between pre-test scores and post-test scores across the two experimental conditions (i.e., Control group and EDGE Group). If game-based exercises provided additional benefit to the AtN course, then the EDGE Group should have a greater *increase* in scores than the Control Group. In addition to the analysis of test scores, training effectiveness was determined from questionnaire responses on students' perceptions of the practical exercises. In this case, training effectiveness was determined (a) by affirming responses to the questionnaire items and (b) by differences in the frequencies of responses between the two experimental conditions. If game-based training was perceived as effective in the AtN course, then the EDGE Group should both have "positive" responses to questionnaire items and have a higher frequency of positive responses than the Control Group. Finally, an analysis of student characteristics was conducted to see if differences in background variables could account for any differences in post-test scores. This analysis could (a) further illuminate the nature of any relative effects of game-based training in the AtN course and (b) add to the evidence that describes how game-based training is best applied (e.g., Topolski, 2010). Each analysis was conducted at the .05 level of *alpha* error. Appropriate *post-hoc* analyses are also reported.

Pre-test and Post-test Scores

The percent correct on each AtN course test was compared in a 2 (pre-test, post-test) X 2 (Control Group, EDGE Group) mixed-factors ANOVA. Overall, test scores increased nearly 35% ($F(1, 187) = 636.76$, $MSe = .02$, $p < .01$), but there was no difference in test-score increase between the experimental conditions ($F(1, 187) = 2.87$, $MSe = .02$, $p = .09$). Figure 3 presents the percent correct for each test across experimental groups. The results indicated that the course and practical exercises were effective at increasing human-intelligence skills. However, the game-based training did not have unique effect on the improvement of skill.

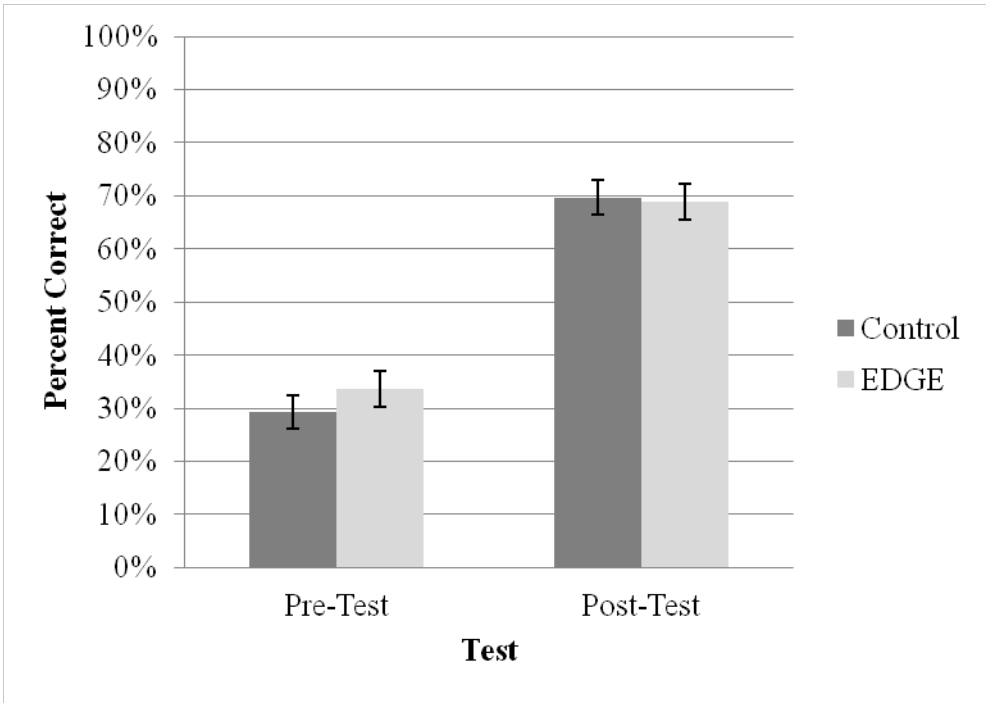

Figure 3. Percent Correct for Each AtN Course Test across Experimental Groups. Error bars represent 95% confidence intervals.

Training Effectiveness Items.

On the AtN Post-Training Questionnaire, students indicated the level of agreement to 16 statements about the impact of the practical exercises on learning outcomes. The response frequencies for each statement were analyzed with *chi-square* to determine (a) the perception of the impact of the practical exercises on training effectiveness and (b) experimental group differences in those perceptions. The response frequencies for all 16 statements and the statistical results for the analyses of the frequencies are given in the Appendix B. An inspection of Appendix B clearly shows that students overwhelmingly "agreed" (or "strongly agreed") with all 16 statements. The high level of "agree" responses indicated that the practical exercises were perceived as effective for training.

However, the pattern of responses differed between the two groups for six of the 16 statements. For statements that differed, the Control Group had more "agree" and "strongly

agree" responses and fewer "disagree" and "strongly disagree" response than the EDGE Group. An example of this pattern of results can be seen in Figure 4, which presents the percent of responses for the statement, "The Practical Exercise provided challenging experiences." The other statements that followed this general pattern were:

- The Practical Exercise had a valuable impact on my decision-making skill.
- The Practical Exercise helped me focus on Attack the Network mission concepts.
- The Practical Exercise helped me understand information collection and Operational Environment analyses.
- The Practical Exercise was a valuable learning experience.
- The Practical Exercise allowed me to practice measuring Attack the Network level of effectiveness.

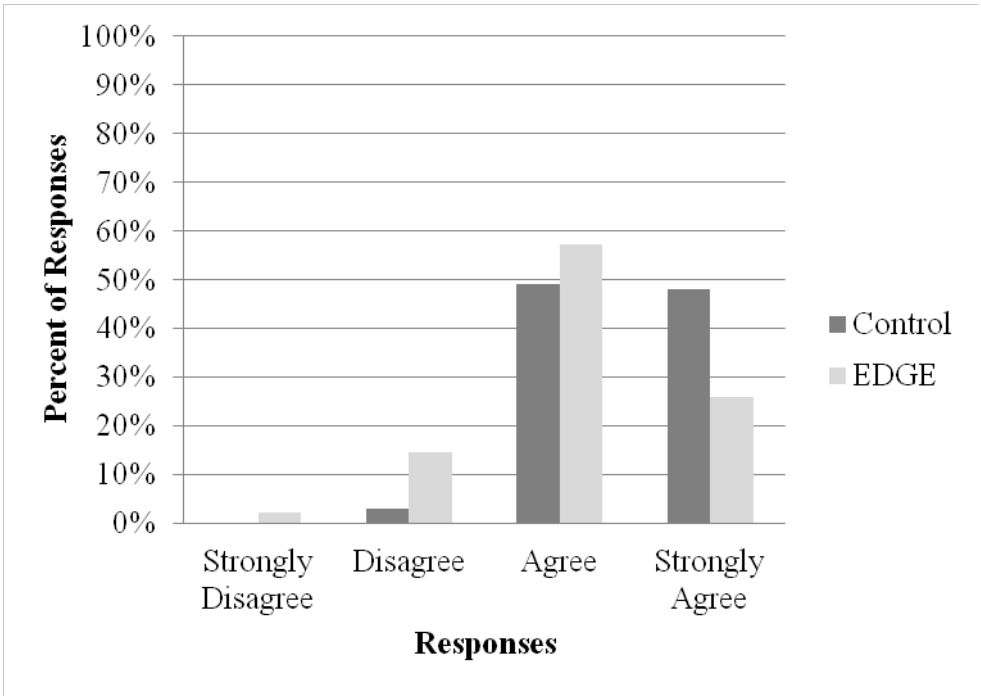

Figure 4. Percent of Responses to the Statement, "The Practical Exercise provided challenging experiences" across Experimental Groups.

As with the results for the AtN course tests, the results of students' perceptions of the practical exercises indicated that the training was effective but there was little difference in effectiveness between experimental groups. The few group differences that emerged in the students' perceptions data, however, appeared to favor the paper-based exercises as the more effective training. The reason for the more favorable perception of paper-based exercises was unclear. One speculation was that the paper-based exercises required more instructor-student and student-student interactions. However, a more careful examination of participant characteristics may also indicate why the paper-based exercises were perceived as being effective.

Participant Characteristics Items

Additional self-report items on the ATN Post-Training Questionnaire (see Appendix A) were considered as contributing factors to the scores on the AtN course post-test. Those items assessed factors such as formal military decision making experience and digital-technology experience and confidence. The only group difference found among the responses for these questionnaire items was experience with Intelligence Preparation of the Battlefield (IPB) process. Students in the EDGE Group self-reported more experience with IPB than the Control Group (χ^2 (3) = 8.80, $p < .05$). However, an examination of Figure 5 reveals that this group difference was primarily driven by differences in frequencies for "little experience" and "some experience" responses. As such, it did not appear that the difference in experience with IPB was overwhelming. In addition to the lack of group differences across most items, no items produced statistically significant correlations with post-test scores (highest $r = .14$). Thus, it did not appear that participant characteristics could account for the patterns of results seen in the AtN post-test scores.

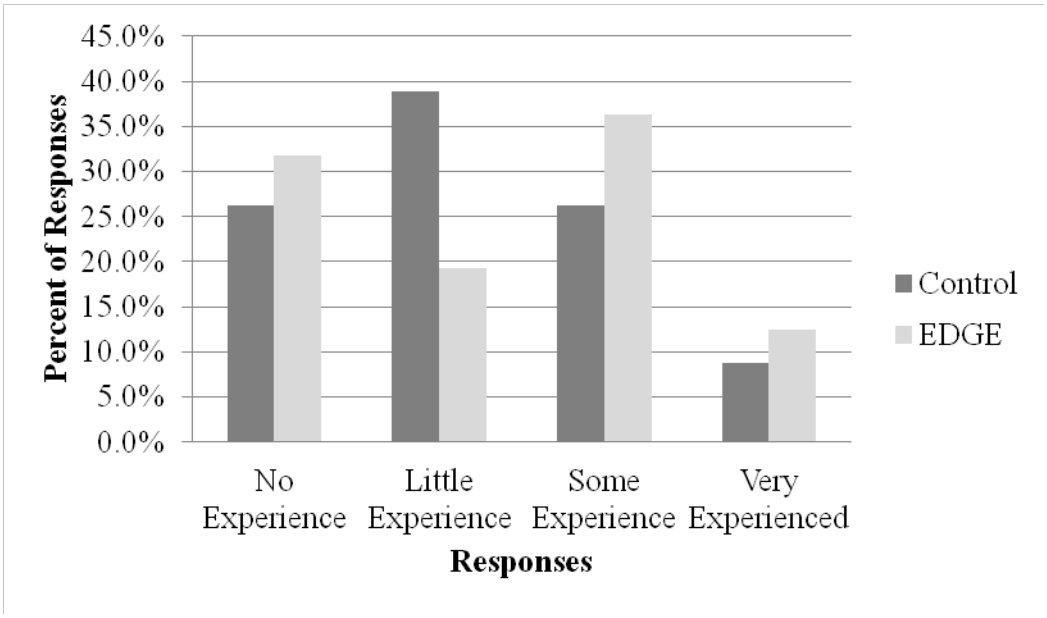

Figure 5. Percent of Responses for "Experience with using Intelligence Preparation of the Battlefield Process" across Experimental Groups.

Discussion

The purpose of the research reported here was to investigate the extent to which game-based training could be used to enhance the training of human-intelligence skills. In this case, EDGE was used to deliver practical exercises as part of the Army's AtN course. The game-based (i.e., EDGE) practical exercises did no better in increasing end-of-course test scores than did traditional paper-based practical exercises. In addition, the paper-based practical exercises were perceived as more beneficial to some learning and course outcomes than the game-based practical exercises. These results add to the growing literature that *fails* to find a relative advantage of game-based training (e.g., Topolski, et al., 2010) and highlight the need for more controlled comparisons of game-based training effectiveness.

Clearly, there was no advantage for game-based training in the present comparison. However, caution should be taken in interpreting these results because of procedural differences in the two training conditions. Students who used paper-based practical exercises completed the exercises after each phase of instruction, while students who used the EDGE practical exercises did so only at the completion of classroom instruction. That is, the paper-based practical exercises were spaced across sessions, whereas the EDGE practical exercises were massed into one session. It may be the case that the students who used paper-based practical exercises received a distributed-practice benefit to decision-making skills (Crowder, 1976; Taylor & Roher, 2010).

Another procedural difference between the two training conditions was the level of instructor involvement during the practical exercises. In the EDGE practical exercises, the game guided the flow of information and nature of student interactions with minimal instructor involvement. By contrast, the paper-based practical exercises required instructor guidance, and the instructor was involved with answering students' questions. As such, students who used the paper-based practical exercises may have received a benefit from instructor interaction (Thurmond & Wambach, 2004).

Both of these procedural differences (i.e., distributed practice and instructor interaction) should have benefited students who used paper-based practical exercises. It might be argued then that the effects of the procedural differences offset the advantage of game-based training, which led to equivalent end-of-course test performance across the two training conditions. In the same vein, it might be argued that the procedural differences contributed to the more favorable perceptions of effectiveness for the paper-based practical exercises. However, it was equally likely that the procedural differences had no effect on test performance or perceptions of training effectiveness and that game-based training simply provided no advantage for decision-making skills. Likewise, it was possible that *neither* type of practical exercise had any effect on test performance but did influence perceptions of training. That is, it may be the case that the increase in test scores was a result of the course instruction and not the practical exercises.

Obviously, the generality of the current results should not be overstated, and additional empirical research is needed to further clarify the potential effects noted here. The level of instructor interaction would be a logical factor to compare between game-based training and the traditional training environment. A similar research direction would be to explore the efficacy of in-game resources (e.g., pull-down menus, non-player avatars, and help functions) on training outcomes. In-game resources provide similar types of information and guidance as instructors but are always available. By contrast, the in-game resources may not always have the high-level understanding of the skills or the ability to adapt responses to learners needs.

Because the results presented here were not conclusive, it should be noted that game-based training may still hold promise for training human-intelligence skills. EDGE supported several functions critical for developing human-intelligence skills. First, EDGE provided performance-feedback on decisions made while in play, which is critical for learning in virtual environments (Blaiwes, Puig, & Regan, 1973; Bransford, Brown, & Cocking, 2000). Second, the simulated multi-day scenario allowed periods of reflection and opportunities for self-learning (Bringle & Hatcher, 1999) that were not available in the paper-based exercises. Third, EDGE provided opportunities for unscripted interactions with host-nation citizens that were not possible

in the paper-based exercise. Finally, the visual characteristics of the virtual environment allow students to develop information from non-verbal cues (Hinde, 1972; Knapp, Hall, & Horgan, 2013).

The Army Learning Model outlines a set of soldier competencies geared toward 21st century missions (Department of the Army, 2011). These competencies emphasize the need for Soldiers to develop skills in nontraditional areas, such as moral–ethical decision-making, social–cultural awareness, and cognitive reasoning. The Army Leaning Model recognizes the need to train these competencies in relevant and challenging contexts and at the point of need. Game-based training holds the promise to meet the requirements of the Army Learning Model, but additional *conceptual* development of game structure and employment may be required before that promise is met. The findings from the current research were briefed to the Maneuver Center of Excellence Directorate of Training and Doctrine and to the U.S. Army Research Laboratory – Human Research and Engineering Directorate Simulation and Training Technology Center. The findings were used to inform decision about including game-based training in the AtN course.

References

Beal, S. A. (2007). *Assessment of two desk-top computer simulations used to train tactical decision making (TDM) of small unit infantry leaders* (Research Report 1869). Arlington, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. (DTIC No. ADA468772).

Beal, S. A. (2009). *Instructor-facilitated vs. stand-alone tactical game training* (Research Report 1892). Arlington, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. (DTIC No. ADA790350).

Blaiwes, A. S., Puig, J. A., & Regan, J. J. (1973). Transfer of training and the measurement of training effectiveness. *Human Factors, 15*, 523 – 533.

Blankenbeckler, P. N., Graves, T. R., & Wampler, R. L. (2013). *Addressing point of need in interactive multimedia instruction: A conceptual review and evaluation* (Research Report 1969). Fort Belvoir, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. (DTIC No. ADA593946).

Bransford, J. D., Brown, A. L., & Cocking, R. R. (2000). *How people learn: Brain, mind, experience, & school*. Washington, DC: National Academy Press.

Bringle, R. G., & Hatcher, J. A. (1999). Reflection in service learning: Making meaning of experience. *Educational Horizons, 77*, 179-185.

Crowder, R. G. (1976). *The principles of learning and memory*. Oxford, UK: Lawrence Erlbaum Associates Ltd.

Department of the Army, U. S. (2011). *The U.S. Army learning concept for 2015* (TRADOC PAM 525-8-2). Fort Eustis, Virginia: Author.

Dickey, M. D. (2007). Game design and learning: A conjectural analysis of how massively multiple online role-playing games (MMORPGs) foster intrinsic motivation. *Educational Technology Research and Development, 55*, 253-273.

Dwyer, T., Griffith, T., & Maxwell, D. (2011). Rapid Simulation Development Using a Game Engine-Enhanced Dynamic Geo-Social Environment (EDGE). *Proceedings of the Interservice/Industry Training, Simulation & Education Conference, 2011*. Arlington, VA: National Training Systems Association.

Gray, B. (1995). *Playing war: The applicability of commercial conflict simulations to military intelligence training and education*. Bolling Air Force Base, Washington, DC: DIA Joint Military Intelligence College.

Hays, R. T. (2005). *The effectiveness of instructional games: A literature review and discussion* (NAWCTSD-TR-2005-004). Orlando, FL: Naval Air Warfare Center Training Systems Division. (DTIC No. ADA441935).

Hinde, R. A. (1972). *Non-verbal communication*. Oxford, UK: Cambridge University Press.

Knapp, M., Hall, J., & Horgan, T. (2013). *Nonverbal communication in human interaction*. Boston, MA: Cengage Learning.

Lampton, D. R., Clark, B., & Knerr, B. W. (2003). Urban combat: The ultimate extreme environment. *Journal of Human Performance in Extreme Environments, 7*, 57-62.

Pleban, R. J., & Salter, M. S. (2001). Training and Assessing Decision-Making Skills in a Virtual Environment. *Proceedings of the Interservice/Industry Training, Simulation & Education Conference, 2001*. Arlington, VA: National Training Systems Association.

Ratwani, K. L., Orvis, K. L., & Knerr, B. W. (2010). *Game-based training effectiveness evaluation in an operational setting* (Study Report 2010-02). Arlington, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. (DTIC No. ADA530660).

Ryan, R. M., Rigby, C. S., & Przybylski, A. (2006). The motivational pull of video games: A self-determination theory approach. *Motivation and emotion, 30,* 344-360.

Singer, M. J., Long, R. Stahl, J. & Kusumoto, L. (2008). *Formative evaluation of a massively multi-player persistent (MMP) environment for asymmetric warfare exercises* (Technical Report 1227). Arlington, VA: US Army Research Institute for the Behavioral and Social Sciences. (DTIC No. ADA480016).

Taylor, K., & Roher, D. (2010). The effects of interleaved practice. *Applied Cognitive Psychology, 24*,837 – 848.

Temby, P., Stephens, A., & Whitney, S. J. (2008). *Game-based training for infantry teams: A controlled evaluation of the effectiveness of VBS for training section attack* (DSTO-CR-2008-0295). Edinburgh, South Australia: Commonwealth of Australia.

Thurmond, V. A., & Wambach, K. (2004). Understanding interactions in distance education: A review of the literature. *International Journal of Instructional Technology and Distance Learning, 1,* 9 – 25.

Topolski, R., Leibrecht, B., Cooley, S., Rossi, N., Lampton, L., & Knerr, B. (2010). *Impact of game-based training on classroom learning outcomes* (Study Report 2010-01). Arlington, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. (DTIC No. ADA531677).

Vogel, J. J., Greenwood-Ericksen, A., Cannon-Bowers, J., & Bowers, C. A. (2006). Using virtual reality with and without gaming attributes for academic achievement. *Journal of Research on Technology in Education, 39,* 105-118.

Wolfe, J. (1997). The effectiveness of business games in strategic management course work. *Simulation & Gaming, 28,* 360-376.

APPENDIX A

AtN Post-Training Questionnaire

Training Experience Questionnaire

Instructions: In an effort for continuous improvement of training, the Maneuver Center of Excellence would like to have your input on your experiences in this course. For each item, please provide your honest answer. *Your participation in this questionnaire is voluntary. You may stop responding at any time and submit the questionnaire to the designated person without consequence.*

1. Rank _____
2. MOS/Branch _____
3. Time in service: Years_____ Months _____
4. How long have you been in your current unit? Years _____ Months_____
5. What is your current duty position? _____
6. How many months have you been in this position? _____
7. Please list any battalion or brigade staff experience you have.

   _____

   _____

   _____
8. Do you have combat theater experience? No_____ Yes_____
9. How many combat theater deployments have you had? _____
10. What is your level of confidence in using digital technology (i.e. Personal Computer, Smartphone, or Tablet)? (**Mark one only**)

None	***Low***	***Some***	***High***
☐	☐	☐	☐

11. How many hours per week do you play tactical (i.e. first person) or strategic (i.e. turn-based) computer/video games? (**Mark one only**)

0 – 4hours	**5 – 8 hours**	**9 - 12 hours**	**12 hours +**
☐	☐	☐	☐

For each of the following tasks, please indicate your level of performance experience.	Very Experience	Some Experience	Little Experience	No Experience
1. Applying METT-TC	☐	☐	☐	☐
2. Applying OAKOC	☐	☐	☐	☐
3. Combat Profiling	☐	☐	☐	☐
4. Considering Combat Multipliers	☐	☐	☐	☐
5. IPB Process	☐	☐	☐	☐
6. Making informed decisions to conserve lives and resources to avoid unnecessary risk	☐	☐	☐	☐
7. Making informed decisions based on implemented courses of action	☐	☐	☐	☐
8. Identifying feasible and effective control measures in the absence of specific standards	☐	☐	☐	☐
9. Develop reasonable alternatives to accomplish mission	☐	☐	☐	☐

The following items refer to your experience with the course Practical Exercises that you completed. For each of the statements, please indicate the extent to which you agree or disagree.	Strongly Disagree	Disagree	Agree	Strongly Agree
1. The Practical Exercises provided me an opportunity to practice making sound tactical decisions.	☐	☐	☐	☐
2. The Practical Exercises improved my ability to make more rapid tactical decisions.	☐	☐	☐	☐
3. The Practical Exercises made me more confident in my ability to make tactical decisions.	☐	☐	☐	☐
4. The Practical Exercises provided challenging experiences.	☐	☐	☐	☐
5. The Practical Exercises had a valuable impact on my decision-making skills.	☐	☐	☐	☐
6. The Practical Exercises helped me focus on Attack the Network mission concepts.	☐	☐	☐	☐
7. The Practical Exercises helped me understand information collection and Operational Environment analyses.	☐	☐	☐	☐
8. The Practical Exercises allowed me to practice the types of decisions I must make as a small unit leader.	☐	☐	☐	☐
9. The Practical Exercises were a valuable learning experience.	☐	☐	☐	☐
10. The Practical Exercises allowed me to practice assessing needs and requesting enablers to engage a network.	☐	☐	☐	☐
11. The Practical Exercises allowed me to practice interacting with host nation citizens.	☐	☐	☐	☐
12. The Practical Exercises allowed me to practice collaborating with intergovernmental organizations, non-governmental organizations, or other agencies to engage a network.	☐	☐	☐	☐
13. The Practical Exercises improved my ability to determine strengths and weaknesses of a network.	☐	☐	☐	☐
14. The Practical Exercises made me more confident in my ability to identify High Payoff Targets (HPT's).	☐	☐	☐	☐
15. The Practical Exercises helped me determine best targeting method to employ against HPTs.	☐	☐	☐	☐
16. The Practical Exercises allowed me to practice measuring Attack the Network level of effectiveness.	☐	☐	☐	☐

Thank you for your Participation.

APPENDIX B

Response Frequencies and Test Statistics for Training Effectiveness Items

Response frequencies for each experimental group on AtN Post-Training Questionnaire statements of practical exercise training effectiveness. The test statistic (i.e., *chi square*) is provided. Statistically significant differences in response frequencies between experimental groups (i.e., Control and EDGE) at the *alpha* = .05 level are indicated by statements in bold type and asterisks next to the test statistic.

The Practical Exercises provided me an opportunity to practice making sound tactical decisions.

	Strongly Disagree	Disagree	Agree	Strongly Agree	
Control	0	2	56	42	$\chi^2 = 3.46$
EDGE	2	4	50	33	

The Practical Exercises improved my ability to make more rapid tactical decisions.

	Strongly Disagree	Disagree	Agree	Strongly Agree	
Control	1	12	54	33	$\chi^2 = 3.92$
EDGE	3	17	47	22	

The Practical Exercises made me more confident in my ability to make tactical decisions.

	Strongly Disagree	Disagree	Agree	Strongly Agree	
Control	0	10	54	36	$\chi^2 = 4.91$
EDGE	3	11	51	24	

The Practical Exercises provided challenging experiences.

	Strongly Disagree	Disagree	Agree	Strongly Agree	
Control	0	3	49	48	$\chi^2 = 16.51^*$
EDGE	2	13	51	23	

The Practical Exercises had a valuable impact on my decision-making skills.

	Strongly Disagree	Disagree	Agree	Strongly Agree	
Control	0	5	55	40	$\chi^2 = 11.77^*$
EDGE	2	12	56	19	

The Practical Exercises helped me focus on Attack the Network mission concepts.

	Strongly Disagree	Disagree	Agree	Strongly Agree	
Control	1	2	43	54	$\chi^2 = 15.08$*
EDGE	3	7	54	25	

The Practical Exercises helped me understand information collection and Operational Environment analyses.

	Strongly Disagree	Disagree	Agree	Strongly Agree	
Control	0	5	43	52	$\chi^2 = 9.06$*
EDGE	1	5	55	28	

The Practical Exercises allowed me to practice the types of decisions I must make as a small unit leader.

	Strongly Disagree	Disagree	Agree	Strongly Agree	
Control	1	8	53	38	$\chi^2 = 5.34$
EDGE	1	9	59	20	

The Practical Exercises was a valuable learning experience.

	Strongly Disagree	Disagree	Agree	Strongly Agree	
Control	0	2	41	57	$\chi^2 = 9.15$*
EDGE	1	7	46	34	

The Practical Exercises allowed me to practice assessing needs and requesting enablers to engage a network.

	Strongly Disagree	Disagree	Agree	Strongly Agree	
Control	1	10	51	38	$\chi^2 = 2.54$
EDGE	0	8	54	27	

The Practical Exercises allowed me to practice interacting with host nation citizens.

	Strongly Disagree	Disagree	Agree	Strongly Agree	
Control	8	22	48	22	$\chi^2 = 6.00$
EDGE	2	12	49	25	

The Practical Exercises allowed me to practice collaborating with intergovernmental organizations, non-governmental organizations, or other agencies to engage a network.

	Strongly Disagree	Disagree	Agree	Strongly Agree
Control	5	29	47	19
EDGE	3	22	46	18

$\chi^2 < 1$

The Practical Exercises improved my ability to determine strengths and weaknesses of a network.

	Strongly Disagree	Disagree	Agree	Strongly Agree
Control	2	4	55	38
EDGE	1	8	60	20

$\chi^2 = 6.96$

The Practical Exercises made me more confident in my ability to identify High Payoff Targets.

	Strongly Disagree	Disagree	Agree	Strongly Agree
Control	2	10	49	38
EDGE	3	13	51	22

$\chi^2 = 4.38$

The Practical Exercises helped me determine best targeting method to employ against High Payoff Targets.

	Strongly Disagree	Disagree	Agree	Strongly Agree
Control	1	15	50	34
EDGE	2	14	56	17

$\chi^2 = 5.75$

The Practical Exercises allowed me to practice measuring Attack the Network level of effectiveness

	Strongly Disagree	Disagree	Agree	Strongly Agree
Control	0	2	60	38
EDGE	0	13	55	21

$\chi^2 = 12.59$*